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# TITLE

PROGRESS REPORT - PLANTATION INSECT STUDIES

1940 and 1941

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# PROGRESS REPORT - PLANTATION INSECT STUDIES

1940 and 1941

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# PROGRESS REPORT - PLANTATION INSECT STUDIES

## 1940 and 1941

The studies of plantation insects have been carried on at the Institute of Forest Genetics, near Placerville, California. The Institute, a branch of the California Forest and Range Experiment Station, is engaged in studies of the hereditary characteristics of forest tree species for the purpose of developing superior lines for reforestation. Each tree in the plantings is a unit in an experiment and, as such, represents a considerably greater value than would a similar tree in the forest. Consequently, protection from insects needs to be carried on in a much more intensive manner than would be warranted in any western forest. Instead of working toward the general protection of the stand, it becomes necessary to protect the individual tree. Furthermore, the insects involved are frequently species of little or no importance in the forest.

The Berkeley laboratory for several years has given advice on insect problems of the Institute as requested. In recent years the injury has become so severe and our knowledge of the insects involved has been so slight that a study was set up to develop methods of protecting these trees. It has not been possible to carry this work as a full time project, but in each of the 1939, 1940, and 1941 seasons, a period of several weeks was given to the problem. Because of curtailment of funds it will be necessary to drop the project for the present. This progress report has been prepared to cover the work done since the last report. Except for a manuscript on the resin midge and a joint manuscript with the Institute on tree susceptibility, future work will be limited to supplying technical advice when requested.

### 1. The Ponderosa Pine Resin Midge (*Retinodiplosis* sp.)

The resin midge continues to be the most serious insect problem. Injury has become more severe each year in the older plantings and has become established in the 1937 planting. Severe damage, so far, has been limited to ponderosa pine, although a light infestation has developed in some Jeffrey pines.

Biology: During the past two seasons the study of the biology of the resin midge has been limited to a few observations of the life history to recheck the time of occurrence of the various phases, and rearings of parasites to follow the level of the parasite population. It was found that the life cycle followed essentially the same schedule previously reported. The eggs are deposited on the expanding branch and leader tips in April and May. The larvae hatch in approximately 6 days, bore into the phloem, and feed until full grown, the following spring. They then migrate out on the needles from cocoons and pupate (late February to April). Adults emerge from the latter part of March until early in May.

The incidence of parasitism as estimated from rearings from larvae and pupae of the resin midge was approximately 20 percent in 1940 and 25 percent in 1941. This has not been sufficient to bring about any appreciable reduction in the severity of the resin midge injury. The principal parasite species are Platygaster diplosidis (Ashm.)1/ emerging from resin midge larvae and pupae, and Muridinota rufiventris Cir.2/ and Amblyaerus sp.2/ emerging from resin midge pupae. The first species predominated in the 1940 rearings and the second species in 1941.

Another cecidomyiid was previously reported to be associated with the resin midge, but differed in habit in that several larvae worked in a single, slime filled, necrotic pit. This species continues to be present in small numbers. It has been identified as Asynapta americana Felt.3/

Control: After the essential points in the life cycle had been worked out, in the 1939 season, it was decided that the most advantageous time for applying control measures would be during the pupal stage. Treating just after the emergence of the first few adults should catch practically the entire population in the pupal stage, and a single application should do the work. Control applied to any of the other stages would have certain disadvantages. The period of oviposition and hatching is so spread out that several applications would be required. The immature larvae, being concealed in the host tissue could not be reached by spray materials. The migration of the mature larvae also covers a rather long period, and comes during the heavy spring rains making success of a single application unlikely. The adults are free flying, so there is little possibility of affecting high mortality of that stage. For these reasons practically all tests have been applied to pupae.

During April 1940 a series of oil sprays was tested for control of pupae. Pine needles bearing cocoons were cemented on 2" x 6" cardboard strips so that the portion of the needles bearing the cocoons projected about one inch beyond the edge of the cardboard. Twenty-five needles were mounted on each strip. The strips were then placed in wooden racks, and the spray applied by means of a bucket pump. Mortality was determined by the number of adults emerging following treatment as compared to emergence in checks. It was soon observed that the spray oils penetrated very slowly, or not at all, if the shiny outer surface of the cocoons were unabraded, but if the surface were even lightly scratched, the oil would go through the cocoons. Following this discovery, two sets of 100 pupae were sprayed with each mixture. In the first set the cocoons were unaltered, while in the second the surface of each cocoon was lightly scratched before the spray was applied. The results, given in Table 1, show that the pupae were quite readily killed by spray oils when the latter can go into the cocoon. The heavy oil penetrated the unscratched cocoons somewhat better than the other oils, but this grade is too heavy to be used on ponderosa pine foliage.

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1/ Determined by C. F. W. Muesebeck.
2/ Determined by A. B. Gahan.
3/ Determined by C. T. Greene.

Table 1. Oil Sprays Applied to Resin Midge Cocoons

| Materials[1/] | Mortality Percent | |
|---|---|---|
| | Cocoons unscratched | Cocoons scratched |
| 1. Heavy tank mix oil 4 gal., nicotine sulfate (40% nicotine) 1 pt., blood albumin 4 oz. | 86 | 100 |
| 2. Heavy tank mix oil 2 gal., ingredients except oil as in 1. | 79 | 96 |
| 3. Light medium tank mix oil 4 gal., ingredients except oil as in 1. | 81 | 97 |
| 4. Light medium tank mix oil 2 gal., ingredients except oil as in 1. | 65 | 89 |
| 5. Light medium tank mix oil 1 gal., ingredients except oil as in 1. | 41 | 79 |
| 6. Light medium oil emulsion 4 gal., nicotine sulfate as in 1. | 77 | 92 |
| 7. Light medium oil emulsion 2 gal., nicotine sulfate as in 1. | 45 | 85 |
| 8. Light medium oil emulsion 1 gal., nicotine sulfate as in 1. | 31 | 71 |
| 9. Light medium tank mix oil 1 gal., pyrethrum concentrate (pyrethrins 3.6%) 2 oz. | 41 | 72 |
| 10. Light medium tank mix oil 1 gal., rotenone powder (rotenone 0.58%, other cube resins 1.74%) 4 lbs. | 35 | 78 |
| 11. Check | 6 | 4 |

1/ Quantities given are for 100 gallons of spray mixture.

These results demonstrate that the problem of finding an effective control for resin midge pupae is primarily a matter of finding an effective penetrant. The problem was discussed with Dr. J. W. McBain of Stanford University, who supplied a number of commercial preparations tested in 1941. In this test a 1% water dispersion of each compound was prepared, a cocoon still attached to a needle was dipped in the dispersion, and the rate of penetration observed under a dissecting microscope. Several cocoons were used in this manner with each penetrant, but none of the materials was even moderately effective. The agents tested are given in the following list:

| | |
|---|---|
| Aerosol, OT | Grasselli Spreader |
| Amonium acid phosphate | Lecithin |
| Anhydrous wetal | Lime sulfur |
| Aresket | Pine-oil emulsifier |
| Botano Liquid Spreader | Product Q Paste |
| Cellosolve acetate | Santomerse D |
| Cepyrin chloride | Sodium carbonate |
| Di-butyl-phthalate | Triethanol amine |
| Diethylene glycol | Trisodium phosphate |
| Draft | Triton B |
| Glycerine | Zephiran |

When these materials proved ineffective an attempt was made to learn something of the nature of the outer surface of the cocoons. First, several solvents were applied to the surface, and the coating was found to be readily removed by the following: Lower alcohols (methyl, ethyl, propyl, butyl), amonium hydroxide, amyl acetate, and sodium hydroxide, but only at concentrations of 20 percent or more. The coating was not affected by benzyl alcohol, hydrocarbon solvents (benzene, xylene, kerosene), or hydrochloric acid. Next, about 200 cocoons were boiled in ethyl alcohol to dissolve the outer coating, and the dissolved material separated by evaporating off the alcohol. When isolated this material is white in color, has a slight pine odor, and appears to be of a resinous nature. It is not known just how this coating is laid down on the outer surface of the cocoon, but it does appear to be the principal obstacle in arriving at a satisfactory control.

Another possible method of control of the pupal stage is by the application of a material to seal the cocoon preventing the escape of the adults. Several materials were tested by preparing water dispersions in concentrations that would be practical for field use, dipping 50 pupae in each preparation, and noting the subsequent emergence of adults (Table 2). None of the mixtures was sufficiently effective for further testing.

Table 2. Materials Applied to Prevent the Emergence of Adults from Cocoons

| Material 1/ | Mortality Percent |
|---|---|
| 1. Bill poster's paste 10 lbs. | 12 |
| 2. Casein glue 2 lbs. | 20 |
| 3. Linseed oil ½ gal., pine oil emulsifier 2/ ½ pint | 28 |
| 4. Miscible cellulose 10 lbs. | 28 |
| 5. Sodium silicate ($Na_2Si_4O_9$) 50 lbs. | 48 |
| 6. Check | 8 |

1/ Quantities given are for 100 gallons of mixture.
2/ Proprietary preparation of California Spray Chemical Corp.

In March of 1941 arsenic sprays were applied to several heavily infested trees to see whether the mature larvae in migrating out on the needles to pupate would pick up enough of the poison on the integument to cause death by direct absorption. In applying the mixtures the trees were literally whitewashed. The trees were not injured by the excessive arsenic deposit, but the mortality of the larvae was so low that it was not worth while to make mortality counts. The mixtures applied were as follows:

| | | |
|---|---|---|
| 1. | Lead arsenate | 4 lbs. |
| | "Dynamite" spreader | 4 oz. |
| | Light medium oil | 2 pints |
| | Water to make | 100 gal. |
| 2. | Lead arsenate | 8 lbs. |
| | "Dynamite" spreader | 4 oz. |
| | Fish oil | 2 quarts |
| | Water to make | 100 gal. |
| 3. | Lead arsenate | 1 part by weight |
| | Fish oil | 0.2 " " " |
| | Aresket | 0.04 " " " |
| | Water | 1.5 " " " |

A field control test of vapodust sprays was made in the hybrid planting on April 21, 1940 by the writer and Mr. W. B. Parker of the California Spray Chemical Corp. This block of ponderosa pine crosses is isolated from other ponderosa pines and therefore free from heavy reinfestation from the other plantings. Four rows (approximately 40 trees) were treated with Pyrethrum Vaporol, 3 rows (25 trees) with Summer Vaporol, and 2 rows (20 trees) with Winter Vaporol. Application was made with a Bean vapoduster operated at 20 to 40 pounds pressure. These insecticides were quite effective in killing the eggs and small larvae that had not entered the shoots, but they did not kill the pupae. There was some foliage injury from the oils and some of the trees which had been severely injured by the resin midge had some twig burning. The latter was brought about by the oil entering the stems through the open resin midge pits on the 1939 growth.

A general spraying of the other plantings was carried out by the Institute on May 1 and 2, 1940 in the hope that some retarding of the infestation might be effected even though entirely satisfactory control did not result. The spray used was a 2 percent light medium tank mix oil emulsion. The treatment did not materially reduce the resin midge population and some spray injury appeared on the trees severely injured by resin midge.

If it should be found to be feasible to reopen this work at some future time, the following suggestions are offered:

1. From the standpoint of cost a treatment requiring only a single application is essential. This will, therefore, limit control work to the pupal stage.

2. Effective killing of the pupae is still a problem of finding an efficient penetrant to permit the toxicant to pass through the cocoon. While the heavy oils showed some promise in laboratory tests, these heavy fractions are much too toxic to the foliage to permit their use. Dr. Keller of the Insecticide Division has suggested using varying concentrations of acetone, dioxan, sodium tetraphosphate, and turkey red oil. Mr. Bruce, Chemist in the Forest Experiment Station, suggested trying a mixture of acetone, alcohol, and benzene, with a small amount of paraffin added to retard evaporation.

3. The use of sealing agents on the cocoons showed so little promise that there seems to be little possibility of finding a material that would be effective in low concentrations.

Host Susceptibility: It was previously reported that ponderosa pines in which the new shoot growth is covered with a sticky exudate during the period of rapid elongation in the spring are apparently more heavily infested with resin midge than are those ponderosa pines in which the sticky exudate is absent. It was suspected that the sticky secretion attracted the ovipositing females and further observations have supported this view. In the cases where eggs were deposited on nonsticky trees normal progeny developed indicating that these trees possess nothing to inhibit development of the insects. The stickiness disappears, probably by oxidation, as the season progresses.

To determine whether this character could be used to classify ponderosa pines according to resin midge susceptibility, Mr. Lloyd Austin of the Institute, and the writer set up an arbitrary rating system in which resin midge injury was divided into 10 classes and degree of stickiness into 5. All ponderosa pines in the 1929 progeny block and the arboretum were then classified by subprofessional and ERA employees. A preliminary summary of the data prepared by the statistical section of the California Forest and Range Experiment Station shows an excellent correlation between degree of injury and stickiness of the shoots. A joint manuscript on this phase of the problem is now in preparation.

When it became necessary to thin the 1929 planting and the arboretum, the resin midge injury had become so severe that, instead of selecting trees on a silvicultural basis as had been planned, trees were marked according to resin midge injury. Trees were removed during the winter of 1940-41, and burned before the mature larvae started to migrate. Some 60 percent of the ponderosa pines in the 1929 planting were eliminated and 5 to 10 percent of that species in the arboretum. It will be interesting to see how the removal of a large proportion of the resin midge population and the most attractive host material will affect the remaining infestation.

Silvicultural control

2. The Tip Moth (Rhyacionia sp.)

This insect is again increasing, particularly in the 1937 planting. It has not been possible to do any work on the control of the tip moth, but from observations reported by employees of the Institute, there is evidently

only one generation per year. To protect the 1937 planting it was suggested that the trees be sprayed with lead arsenate when the first larva is found (sometime in May), and when plenty of WPA and CCC labor was available, that the larvae be hand picked before they enter the stem. This procedure has reduced tip moth injury.

3. Aphis (Aphididae)

Aphis are always quite numerous each spring, but natural agencies have brought about control each year in all but the smaller trees. In the seed beds and the plantings satisfactory control has resulted from the application of Black Leaf 40, 1 pint per 100 gallons of water.

The following determinations have been received on collections made at the Institute:

Cinara curvipes (Patch) - large black aphis on trunk of white fir
Cinara sp. - large gray aphis on trunk of sugar pine
Schizolachnus pini-radiatae (David) - small gray or black aphis, a general feeder on pine foliage.
Pilachnus sp. - a small brown aphis on the twigs of ponderosa pine

4. Spider Mites (Paratetranychus sp.)

During the past two seasons the spider mite has not been serious. A few heavily infested spots have appeared in the seed beds and the 1937 planting, but have been readily controlled with Nursery Volck applied as a 1 percent dispersion in water.

5. Sequoia Pitch Moth (Vespamima sequoiae Hy. Edw.)

This Aegerid moth has not caused severe injury in the past although it has been found on several species of pines, principally in the arboretum. In 1941, however, a combined attack of the pitch moth and the red turpentine beetle (Dendroctonus valens Lec.) killed several jack pines in the arboretum. The latter attacked the trees about the root collar making transverse galleries that girdled the trunks. These trees were in poor vigor, and the bark beetles produced no progeny although normal appearing progeny resulted from the pitch moth attacks.